Mike’s Civil PE Exam Guide

Morning Session

SAMPLE VERSION

Mike Hansen, P.E.

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ERRATA

This is the first version of Mike’s PE Exam Guide to be released. Perfection was attempted, but we are all flawed. Visit www.peexamguides.com to report or view corrections that have been made to this material. Your help is appreciated.

Mike’s Civil PE Exam Guide: Morning Session

First Edition

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About the Author

I wrote this book as a 26-year-old engineer who just passed the Civil PE exam with an emphasis on hydrology/environmental for the afternoon section. I graduated from Arizona State University, 2006 and got my Master’s in Business Administration from the John Sterling School of Business in 2009. I currently work as assistant construction manager for Wood, Patel & Associates in Phoenix.

The reason I wrote this exam guide was to help EIT’s get a better grasp of what the morning session of the PE Exam was really like. The problems you will see in this guide are very similar to what you will see on exam day. Many other study guides do not inform you where there formulas come from; they just expect you to know them. I do not expect you to know anything. Each problem solution shows you where to relate every problem in respect to the Civil Engineering Reference Manual (CERM) by Michael R. Lindeburg. It also shows you where and how to tab each page for maximum efficiency. Completing practice problems in this format will increase your odds of passing the PE exam. Enjoy this shortened version of Mike’s Civil PE Exam Guide and buy the full version if you like it. Thanks for your support.

~Mike Hansen, P.E.

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Preface

Many books share knowledgeable information about the NCEES PE exam for civil engineers. The favored book amongst those studying for the PE is the Civil Engineering Reference Manual (The CERM) by Michael R Lindeburg. The CERM closely resembles the clunky, data intensive books we have seen throughout school. It consists of very valuable information amongst lots of theory, history, and other useless information that will not help you pass the test. The CERM however remains the best one stop shop for information on the test. This guide will aid you step-by-step through forty Civil PE Exam morning style questions. Not only do the example problems show you how to complete the problem, but they also show you why certain formulas are used, and where they can be found in the CERM. You should have your own copy of the CERM and this guide for the test. The goal of this guide is not for you to relearn everything from school, but to get you to pass the PE exam.

I studied for the Civil PE Exam with two friends and our study methods made us all pass the first time through (October 2009). Our study methods are reflected in the step-by-step process that are shown in the solutions to each problem. The only book I brought to the exam was the CERM. This guide will help you utilize the CERM to its full potential, as well as give you a firm grasp on how to accurately complete problems within six minutes.

My Issue with other books

We all desperately want to pass the PE exam the first time through. I bought the Practice Problems for the Civil engineering PE Exam by Michael R. Lindeburg, PE and Six-Minute solutions for Civil PE Exam Problems by R.Wane Schneiter, PhD, PE, DEE.
Practice Problems for the Civil Engineering PE Exam

I bought this book of practice problems from the same author of the CERM. It was not to shocking to find out that the practice problems closely resemble the lengthy chapters found in the CERM. What I mean by that is many of the problems in the book give you a time limit of one hour to complete the question. A one-hour long question is ridiculous! You only have an average of six minutes per problem. The book contains a few good examples amongst many terribly in depth questions that you will never see on the exam.

Six-Minute Solutions

Finally, no more hour-long problems to solve. This book makes sense, right? You have an average of six minutes per problem when you take the exam. While the problems in this book are much more realistic than the Lindeburg problems, they were still more difficult than questions on the test. I looked through the book the day following the exam and only saw a couple similar questions. If you desperately need more example problems, even though these are more difficult, they are effective.
Introduction

Test Advice

Only Available with Full Book Purchase

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How to use this book:

STEP 1: Problem Analysis

1. What genre of problem are you looking at?
   a. Hydrology, Traffic, Geotechnical, Structural, or Construction
   b. More specific, do you know what type of problem it is?
      i. Ex] Hydrology – Open Channel Flow

2. Every question asks you to find X, determine what X is from the problem statement.

STEP 2: Reference

1. Flip open your CERM to the appropriate section according to Step 1 by utilizing the tabs you have placed in your book.
   a. Find the formula or equation that applies specifically to the problem.
   b. If you can solve the problem with the equation, do it. Many problems will require 2-steps.
      You may need Y to solve for X in your equation. Look for another equation that solves for Y so you can solve for X. As you look through the solutions, you will understand what is meant here.

Note: I have over 50 tabs in my CERM and during the exam, and I used them frequently. Color Code each section so you have each section with a different color tab. Hydrology had green tabs only, Structural was blue, etc…
STEP 3-X: Solve

1. Steps are clearly described in the following 40 example problems to show you the easiest way to complete a problem.

The Burm Question: (Only offered in Full Version, available at PEexamguides.com)

My friend and study partner Jason Burm, PE was never satisfied with just the answer to the problem. After every question was completed, he would look at it from another angle and say, “What if they asked us about this…” Therefore, I have aptly added a section to some of the problems throughout the guide labeled “The Burm Question”. Utilize the Burm Question as an opportunity to look at the problem differently and it is possible something similar will even be on the exam.
Problem 1

A retaining wall is supporting a soil with the properties shown in the figure. What is the total active resultant per unit width of wall?

   a) 18 kips/ft  
   b) 21 kips/ft  
   c) 24 kips/ft  
   d) 30 kips/ft

Problem 3

A 6ft x 8ft reinforced concrete box culvert (n=0.013) receives a flow of 215cfs from an irrigation canal. The slope of the culvert is 2%. Assume the culvert does not flow full. What is the flow depth in the box culvert?

   a) 2ft  
   b) 3ft  
   c) 5ft  
   d) 6ft
Problem 9

A contractor is looking to build a headwall for a 36” storm drain outlet. How much plywood should he purchase for forming the headwall structure? Assume there is 10% waste over the exact calculation. The headwall is 1ft thick.

a) 89.93 ft^2  
b) 98.93 ft^2  
c) 179.86 ft^2  
d) 193.45 ft^2

Problem 11

In the given truss, what force does member BC experience?

a) 11k Compression  
b) 5k Compression  
c) 1k Tension  
d) 11k Tension

Problem 13

A sports car is speeding down a straightaway at 80MPH when he notices a stop sign rapidly approaching. Considering his perception reaction time (assume 2.5 seconds), how far will he travel before the car comes to a stop? Friction for the pavement is f=0.34 and he is traveling downhill at 4%.

a) 1005ft  
b) 1120ft  
c) 1450ft  
d) 1675ft
**Problem 1 - Solution**

A retaining wall is supporting a soil with the properties shown in the figure. What is the total active resultant per unit width of wall?

a) 18 kips/ft  
**b) 21 kips/ft**  
c) 24 kips/ft  
d) 30 kips/ft

Step 1: Problem Analysis

- This problem is an active earth pressure problem. Geotechnical
- The problem asks to solve for the total active resultant per unit width of wall.

Step 2: Reference

- The equation for total active resultant is found on page 37-4, equation 37.10(b)
- The formula is \( R_a = \frac{1}{2} k_a g H^2 \). The only variable we are missing is \( k_a \).
- We have two theories for active earth problems to solve for \( k_a \), Rankine or Coulomb.
- Coulomb theory is used for problems involving friction (d), a sloping backfill (angle b), and an inclined active-side wall face (angle \( \theta \)).
- Rankine theory disregards wall friction.
- \( k_a \) is solved using the Coulomb theory because we have d, b, and \( \theta \).
- We use the Coulomb theory because we have friction in our problem.
- The Coulomb formula is on page 37-3 in the CERM, equation 37.5.
Step 3: Solve for $K_a$, equation 37.5

- $K_a = \frac{\sin^2(\theta+\phi)}{\sin^2\theta \sin(\theta-\delta) \left(1+\frac{\sin(\phi+\delta)\sin(\phi-\beta)}{\sin(\theta-\delta)\sin(\theta+\beta)}\right)^2}$

- $\theta = 90^\circ$ because the wall is vertical.
- Given Data: $\phi = 29^\circ$, $g = 130\ \text{lbf/ft}^3$, $d = 16^\circ$, $b = 9^\circ$

- $K_a = \frac{\sin^2(90+29)}{\sin^2(90)\sin(90-16) \left(1+\frac{\sin(29+16)\sin(29-9)}{\sin(90-16)\sin(90+9)}\right)^2} = 0.366$

Step 4: Solve for $R_a$

- $R_a = \frac{1}{2} k_a g H^2 = \frac{1}{2} (0.366)(130\ \text{lbf/ft}^3)(30\ \text{ft})^2 = 21,411 \ \text{lbf/ft}$ or b) $21.4 \ \text{kips/ft}$
Problem 3 - Solution

A 6ft x 8ft reinforced concrete box culvert (n=0.013) receives a flow of 215 cfs from an irrigation canal. The slope of the culvert is 2%. Assume the culvert does not flow full. What is the flow depth in the box culvert?

a) 2ft  
b) 3ft  
c) 5ft  
d) 6ft

Step 1: Problem Analysis

- This problem involves open channel flow. It is open channel flow because the problem states that the box culvert is not full. - Hydrology  
- Find the flow depth, d

Step 2: Reference

- Open channel flow begins on pg 19-3.  
- Manning’s equation is the go-to equation for open channel flow.  
- Pg 19-4, Eq. 19.13(b)

Step 3: Break down A and R into terms of depth, d

- Manning’s equation is \( Q = \frac{1.49}{n} AR^{2/3} \sqrt{S} \)  
- In our problem, \( A = 6 \times d \), The A in Manning’s equation is the flow area, not the area of the box culvert.  
- We also need R in terms of d. R is the hydraulic radius and a table on Pg 19-3 gives hydraulic radius for common shapes.  
- \( R = \frac{wd}{w+2d} = \frac{6d}{6+2d} \)
Step 4: Solve for depth, d

\[ Q = \frac{1.49}{n} AR^{2/3} \sqrt{S} \]

\[ Q = \frac{1.49}{n} (6 \times d) \left( \frac{6d}{6+2d} \right)^{2/3} \sqrt{S} \]

Substitute A and R in terms of d

\[ 215 = \frac{1.49}{0.013} 6d \left( \frac{6d}{6+2d} \right)^{2/3} \sqrt{0.02} \]

\[ 2.21 = d \left( \frac{6d}{6+2d} \right)^{2/3} \]

Unfortunately, without a graphing calculator to solve this, you must use trial and error. Start with one of the values offered in the multiple-choice answers. Generally, B is a good first choice. If the value is lower, then the answer is probably (a). If it is higher than you have one more calculation to determine if it is C or D. It is always a good idea to check that your answer makes the equation work.

Let us try b) 3ft.

\[ 2.21 = 3 \left( \frac{6+3}{6+2+3} \right)^{2/3} = 3.93 \]

This does not work, 2.21 does not equal 3.93.

Try a) 2ft.

\[ 2.21 = 2 \left( \frac{6+2}{6+2+2} \right)^{2/3} = 2.258 \]

These values are very close. **a) 2ft is the answer.**
Problem 9 - Solution

A contractor is looking to build a headwall for a 36” storm drain outlet. How much plywood should he purchase for forming the headwall structure? Assume there is 10% waste over the exact calculation. The headwall is 1ft thick.

- a) 89.93 ft²
- b) 98.93 ft²
- c) 179.86 ft²
- d) 193.45 ft²

Step 1: Problem Analysis
- Construction Formwork
- Calculate the amount of plywood including waste that needs to be ordered to form the structure.

Step 2: Reference
- There is no need to reference the CERM. This is a test on your mathematics skill.

Step 3: Solve for the areas that require forms.
- 5ft x 5ft = 25 ft². We have to form the front and back, 25 ft² x 2 = 50 ft²

- Subtract for the pipe.
  - \( \frac{\pi D^2}{4} = \frac{\pi 3^2}{4} = 7.07 \), front and back = 7.07 x 2 = (- 14.14 ft²)

- Add in the wing walls.
  - 10ft x 2ft + (3ft x 10ft)/2 = 35 ft². We have the front and back of two walls. 35 ft² x 4 = 140 ft²

- Add everything up: 50 ft² + (-14.14 ft²) + 140 ft² = 175.86 ft²
- Adjust for waste: 179.86 ft² x 1.10 = d) 193.45 ft²
Problem 11 - Solution

The force in member BC is most nearly?

a) 11k Compression  
b) 5k Compression  
c) 1k Tension  
d) 11k Tension

Step 1: Problem Analysis
- We have a determinate truss
- We are solving for the force in member BC

Step 2: Reference
- Trusses are discussed within Pg.41-13 to 41-16.
- We use the cut and sum method on this problem to determine the force in member BC.
- We first solve for the reactions at the supports and then make a vertical cut through member BC. The sum of all forces in the Y direction = 0

Step 3: Solve for reactions at the supports
- \( \sum M_E = 0 = -A_y(30 \text{ ft}) + 15k(22.5 \text{ ft}) \)
  - \( A_y = 11.25k \)

Step 4: Solve for the force in member BC
- Draw a free body diagram of the truss and make a vertical cut through member BC.
- \( \theta = \tan^{-1} \frac{7.5}{10} = 36.87^\circ \)
- \( \sum F_y = 0 = A_y - 15k \cdot F_{BC} \cdot \cos(36.87) \)
- \( F_{BC} = -4.69k \) (Compression). It is compression because the value is negative. If it were positive, it would be in tension.
Problem 13 - Solution

A sports car is speeding down a straightaway at 80MPH when he notices a stop sign rapidly approaching. Considering his perception reaction time (assume 2.5 seconds), how far will he travel before the car comes to a stop? Friction for the pavement is $f=0.34$ and he is traveling downhill at $4\%$.

a) 1005ft  
b) 1120ft  
c) 1450ft  
d) 1675ft

Step 1: Problem Analysis

- Sight Stopping Distance - Traffic  
- Calculate the stopping distance including perception reaction time

Step 2: Reference

- Pg. 78-9, section 13 covers Stopping Sight Distance
  
  $\circ$ Eq. 78.43(b), $S=1.47t_{sec} \cdot v_{mph} + \frac{v_{mph}^2}{30(f+G)}$

Step 3: Solve for SSD

- $S=1.47t_{sec} \cdot v_{mph} + \frac{v_{mph}^2}{30(f+G)} = 1.47(2.5\text{sec}) \cdot (80\text{mph}) + \frac{80\text{mph}^2}{30(0.34-.04)} = a) 1005.1\text{ft}$

- $G= -.04$ because it is downhill.